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Effect of storage study on the quality attributes of the coconut based snack food

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Abstract
Locally available chief sources of functional ingredients such as roots and spices such as beet root, carrot, ginger and mint have been chosen for the current study for their variable concentrations and compositions in phenolic compounds and other functional characteristics as osmotic infusions in the form of filtrates. Sliced samples (0.8±0.1mm) of matured coconuts (10-12 months old) were subjected to osmotic dehydration for a period from 0 min to 720 min at room temperature. Then the slices were dried in a hot-air oven (HAOD) at temperature 45-60°C for about 6-7 hours and freeze drying (FD) at temperature (-40 to 30°C) for a duration of 14-16 hours. Osmotic medium without the infusion of filtrates of functional ingredients serves as the control. The dehydrated samples were packed in Aluminium foil laminated LDPE pouches with infusion of 100% nitrogen gas composition and stored at ambient temperature till analyzing the shelf life characteristics. The development of ready-to eat coconut based snack food utilizing the functional filtrates dehydrated under the two drying methods exposed favorable results in shelf life characteristics and sensory properties.

Keywords: osmotic dehydration, coconuts, sensory properties, impregnation, antioxidants

1. Introduction
Consumption of nuts is inversely related to the prevalence of cardiovascular diseases, cancer, diabetes and chronic diseases. Boston (2005) [1] suggested that diets with good fats are required in small portions for a healthy well- being. The healthy fats include extra-virgin olive oil, coconut oil, flax seed oil etc., are generally obtained from plant sources such as nuts, oil seeds, avocados and coconuts. Failure to include these fats in everyday meal will result in malabsorption of most of the nutrients responsible for many metabolic functions.

Among nuts, coconuts (*Cocus nucifera*) play a foremost role in our daily life, possess traditional distinctiveness, acts as a functional food and also own biologically active components thereby enhancing health and well being (Kabara, 1984) [6]. Coconuts provide a nutrition source of meat, juice, milk, oil and rich in fibre, vitamins and minerals which has fed and nourished populations around the world for many generations. It is classified as a functional food because it provides many health benefits beyond its basic nutritional content.

Most of the plant foods are rich in micronutrients, functional components and bioactive phytochemicals etc., which are mandatory for the physical and mental health of mankind (Madrau *et al.,* 2009) [12]. The major source of nutraceuticals and functional foods are fruits, vegetables, tubers, roots, green leafy vegetables, nuts & oils seeds etc., with phenolics, carotenoids, vitamins and minerals, possessing antioxidant properties. FAO/WHO (2002) [4] reported that, daily consumption of fruits and vegetables (<400g/d) resulted in reduction of ischemic heart diseases, gastro-intestinal cancers, stroke and many chronic ailments.

The incorporation of these plant extractions, herbal infusions into the basic foods have been concentrated as pre-treatments in the emerging food processing sectors to obtain healthy nutritious foods with enriched nutraceuticals and functional components which are beneficial in general. The drying methods are followed after pre-treatments of various foods using osmotic agents, blanching methods etc., to obtain dehydrated foods with nutritional retention without any enzymatic deterioration with good shelf-life.

Among the various drying methods, hot air oven drying is one of the most common methods used to preserve fruits and vegetables. Freeze drying gives high-quality products after dehydration among various drying techniques. Moreover, freeze drying preserves minerals, vitamins, original flavor and aroma of the food products.

In the emerging trend, consumer with increased awareness on health, consumption of potentially healthy foods has been arrived. In addition to that, consumer view on saving time and money, ready-to-eat foods have been popularized much in the market and are being developed with the assistance of dehydration technologies for better quality products with extended shelf-life. Coconuts are being consumed by people in various forms as ready-to-eat products or as an ingredient in many food products such as fruit ice cream, pie filling and other intermediate moisture food (IMF) products are obtained by osmotic dehydration with assisted drying methods.

The present study emphasis on osmotic dehydration of coconut slices with the impregnation of functional ingredients such as *Beta vulgaris*, *Daucus carota*, *Zingiber officinale* and *Mentha piperita* which holds immense nutritional and antioxidant properties prior to osmotic dehydration by using its filtrates as osmotic medium followed by assisted drying methods namely hot air oven drying and freeze drying. The

shelf-life of the product is highly improved due to efficient moisture removal with lowest water activity at which physico-chemical, nutritional and microbial deteriorations are retarded. With this as a background the objective wasere framed to study the effect of drying methods and impregnation of filtrate of functional ingredients on the shelf-life characteristics and sensory properties of the ready-to-eat coconut based snack

Materials and Methods

Selection and pre-processing of raw materials

Coconuts of good quality were purchased from Pazhamudir Nilayam of Puducherry owing to set of experiments prior to osmotic dehydration. The pre-processing of coconut involved several steps like selection of coconut (10-12 months), husk removal, breaking into halves, endosperm removal from shell and removal of testa (brown skin) from endosperm using a sharp knife. Finally the pre- processed coconut slices were standardised to obtain optimum thickness of slices using slicers and screw gauge.

The impact of osmotic process depends on the thickness of the foods such as vegetables and fruits. Torreggiani (1993) [18] reported that the rate of dehydration due to osmotic process decreases as the thickness of the slices increases which cause difficulty in penetration of the solute inside the foods from the solution. The coconut slices of thickness 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 mm thickness were selected for standardization. However, coconut slice of thickness 0.8 have been selected as optimized one and crispiness and other textural characteristics were found the best in this thickness which is determined after several trials.

The sliced coconut slices were kept in water before beginning of experiments to avoid microbial invasion. The sliced coconut pieces were subjected to steam blanching at temperature 80 to 90ºC for 3-5 minutes to inactivate enzymatic destructions. Further the pre-processed coconut slices osmotically dehydrated using sugar, since it is cheap and cost-effective with increased rate of diffusion and possess good mass transfer properties as reported by Nicoletti *et al*., (2001) [15].

The filtrates obtained from functional ingredients namely *Daucus carota*, *Beta vulgaris*, *Daucus carota*, *Mentha piperita*, *Zingiber officinale* and *Mentha piperita*, purchased from Pazhamudir Nilayam, Puducherry. The processing steps like washing, peeling, grating, grinding of functional ingredients carried out to get fine paste and finally filtered to obtain filtrates using 0.08 mm sieve.

The filtrates were taken in the range from every 5% up to 100% and infused with sugar solution as the osmotic medium (100%). The thickness of coconut slices, sugar concentration and concentration of filtrates were taken in three ratios such as 1:1:1, 1:2:2 and 1:3:3 for standardization purpose.

Process involved in the development of the coconut snack

The coconut slices were osmotically dehydrated with or without the infusion of filtrates of functional ingredients for a time from 0 min to 720 min. The duration of the osmotic process was finalised based on the physico-chemical and physical characteristics of the samples. Dehydration is a preservation method of food preservation which involves effective moisture loss, results in destruction of micro-organisms and leads extended shelf-life. Recently dehydration of foods is ensured after pre-processing methods, especially in case of fruits and vegetables (Kare, 1991). It results in effective reduction in volume and mass, minimise packaging, charges, storage space and transportation costs and makes storage under ambient temperatures conveniently. Hot air drying and freeze-drying methods were used in the present study for further dehydration.

The coconut slices were dehydrated in hot air oven by allowing hot air which passed inside the chamber and the food exposed to hot air, the desirable moisture content was achieved due to moisture removal up to 2-3%. The desired moisture content was optimised at standardised temperature 45-50ºC and time duration 6-7 hours which depends mostly on the nature of the food product. Whereas most of the vegetables and fruits are dehydrated at temperature 50-60ºC to obtain dried foods without much destructive reactions (Demirel and Turhan, 2003) [3].

Freeze drying is one of the sophisticated drying methods used extensively in pharmacological preparations and functional food manufacturing process to increase the keeping quality of the products with meagre chemical destructions during storage. Despite of its greatest instrumentation cost, finds extensive application in enhancing the mass transfer properties of foods in shortest times, better effects on color, texture and taste of the products. The physico-chemical, chemical and sensory characteristics of the food products gets affected in reliance with the type of packages used on storage period. The coconut slices were dried using freeze dryer (Model: Del Vac) by spreading the samples uniformly in the trays, ensured that the instrument works under vacuum condition.

The dehydrated coconut slices derived from both the drying methods were packed in Aluminium Foil Laminated LDPE pouches with the impregnation of 100% nitrogen gas (MAP technology) and stored at room temperature (35ºC) for further analysis.

Standardised Process Parameters

After several combinations and permutations, the process parameters were standardised from the above methods and obtained in the ratio 1:2:2. The thickness of coconut slices, concentration of sugar and concentration of filtrates from the functional ingredients were standardized and above ratio is followed for further processing steps. The sugar and impregnation of filtrates of functional ingredients at 100% concentration provided the coconut based snack with greatest acceptability traits such as texture, taste, crispiness and sweetness, therefore this proportion was selected finally. Whereas the osmotic dehydration of the coconut pieces without the infusion of filtrates of functional ingredients serves as the control.

Quality evaluation of the coconut based snack

After the standardisation of process parameters, various quality attributes of the coconut based snack have been analyzed like physico-chemical and sensory properties as per standard protocols. All analytical determinations were done in triplicates. Values were expressed as mean ± standard deviation.

Physico-chemical properties
Osmotic process is affected by the pH of the osmotic solution. Whereas gradual moisture loss from the foods exposed to osmosis depends on acidic nature of the osmotic solution which has influence on textural properties of vegetables and fruits (Torreggiani, 1993) [18].

Physico-chemical properties of the coconut based snack
The mass transfer mechanism occurred through osmotic process not only cause structural changes in the tissues owing to cellular alterations by dipping of foods in concentrated solutions, but also result in conformity with the product appearance and texture (Chiralt and Fito, 2003).

Texture Analysis-Crispiness (N)
Texture analysis of the coconut based snack was done with a 5mm HDP-CFS cylindrical ball probe by Texture Analyzer (Model No.: 5197, stable Micro Systems HD Plus, Goldalming, Surrey, GU71YL, UK). Each slice of the coconut based snack was placed on the heavy duty platform, the test speed was set to 1mm/sec. The probe compressed nearly 50% of the snack to measure the hardness. Maximum force recorded is calculated as the hardness of the slices. Maximum breaking force (N) and deformation parameters were measured from the force-deformation curve.

Plate 1a: Analysis of texture using Texture analyser

Plate 1b: HDP-CFS cylindrical ball probe

Analysis of colour using Hunterlab colourflex
Color of the coconut based snack was determined using the Hunter's Lab Colorimeter (Model: CX2748, Easy Match QC, Software Version 4.0, Hunter Lab, USA) with spectral reflectance. The Hunter Labs color space is a 3-dimensional rectangular shape color space based on the opponent-colors theory. The determinations of color were reported as L*, a*, b*, whereas (lightness) axis 0 is black, 100 is white, a*(redness-greenness) axis positive values are red; negative values are green and 0 is neutral, b* (yellowness-blueness) positive values are yellow; negative values are blue and 0 is neutral values and Δ E reveals the overall average colour according to Olajide *et al.,* (2010) [16].
The hue angles were determined as the arctangent of b*/a* expressed as degrees and the chroma values were also determined as the square root of the sum of the squared values of both CIE a* and CIE b* as suggested by Olajide *et al.*, (2010) [16]. The chroma and Hue angle were determined by the given formulas,

$$Chroma = \sqrt{a^2 + b^2}$$

Hue angle = tan $^{-1}$ (b/a)

Plate 2: Analysis of colour using Hunterlab colourflex

Sensory analysis
Sensory evaluation is defined as specific discipline used to evoke, measure, analyze and interpret the characteristics of food and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing. The primary function of sensory testing is conducted valid and reliable tests to provide data on which sound decision may be made **(**Meilgaard *et al*., 1991) [13].

Selection of the panel member
Fifteen research scholars of the Department of Food Science and Technology were requested to take up threshold sensitivity test using salt, sweet, sour and bitter as suggested by **(**Meilgaard *et al*., 1991) [13]. They were mixed in the different composition with the code numbers and the subjects were asked to identify the sequence of the concentration from low to high. Essentially the threshold test determines the sensitivity of the panellist to a particular test.

Formulation of score card for sensory evaluation
A score card is a visual exhibit of the most significant information needed to accomplish oneor more objectives, combined and arranged on a single screen so the information could be observed at a glance. The score card is prepared suspiciously and it is clearly printed (Stone *et al*., 2004) [14].

Storage and keeping quality
Storage plays an important role in the safety and the quality of the product. Thirty gram of the snack was packed in Aluminium Foil Laminated LDPE pouches with composition

of 100% nitrogen gas and stored in ambient temperatures. Care was taken to see that the snack was stored in cleanand dry place which was away from sunlight and pests. Sensory evaluation of the snack was done once in 15 days and microbial testing once in 30 days over a period of 90 days to analyse the extent of storage.

Preparation of sample for microbial analysis

Specific agar medium was prepared and poured in the petri plates and kept aside forsetting. One gram of the sample was weighed in aseptic condition and mixed in 10 ml of saline solution. Then the mixture is streaked in the agar medium and incubated. After 48 hours the number of colonies was counted.

Evaluation of the product

Sensory evaluation of hot air oven and freeze dried coconut based snacks prepared under different treatments was carried by a panel of fifteen judges. The various products (Sample A, Sample B, Sample C and Sample D were displayed on a desk and random numbers were consigned to the judges. The judges were asked to examine the samples carefully for appearance, flavor, and taste and color using the 9-Point Hedonic scale. Here, different ratings, ranging from"Like extremely" to "dislike extremely" were given by the judges, specifying the values from 9 (like extremely) to 1 (dislike extremely), respectively. Later on, the scores were averaged for each treatment. Treatments which gained a mean score of 5 and above are acceptable and the one's which score below 5 points were rejected. This experiment was conducted under a controlled environment in cool place. The results of the sensory analysis led way to select the most acceptable products prior to further analysis **(**Meilgaard *et al*., 1991) [13].

Statistical interpretation of the data

The analyses on sensory, physical, chemical, functional, phytochemical and shelf-life characteristics were done using triplicate samples. The data on experimental results were subjected to Analysis of Variance (ANOVA) and differences between means were assessed by LSD and independent sample 't' test using the statistical package SPSS (18 version) to compare the means to determine the most acceptable treatment ($p \leq 0.05$).

Results and Discussion

Physico-chemical characteristics of the ready-to-eat coconut based snack.

Texture analysis-crispiness (N) of the ready-to-eat coconut based snack

The Table 1 depicts the textural characteristics of the ready-to-eat coconut based snack.

Table 1: Texture analysis-crispiness (N) of the ready-to-eat coconut based snack

Filtrate of functional ingredients	Coconut based snacks				p-value (T_1vsT_2)
	Control	T_1	Control	T_2	
A	6.03 ± 0.01^{a1}	5.8 ± 0.02^{b1}	6.7 ± 0.10^{a1}	5.8 ± 0.11^{b1}	0.001*
B		5.9 ± 0.16^{b1}		5.9 ± 0.03^{b1}	0.005*
C		5.7 ± 0.05^{b1}		5.7 ± 0.05^{b1}	0.001*
D		5.8 ± 0.02^{b1}		5.8 ± 0.06^{b1}	0.001*
p-value (Control vs Sample)	0.071^{NS}		0.063^{NS}		

All values are means of triplicate determinations± standard deviation (SD), T_1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

Texture analysis of the samples was performed with a HDP-CFS cylindrical ball probe using Texture Analyzer. Maximum breaking force (N) and deformation were measured from the force-deformation curve. Almost the breaking force for all the samples required around 5.7 to 5.9 N, hence there was no significant difference observed ($p \geq 0.05$). The optimum force required to break the snack was dependent on the hardness of the tissue and cell wall matrices. The concept was made in agreement with Lewicki (1998) who stated that textural behaviour is mainly related to the structural and biophysical properties of foods. Also the increase in time and concentration of solutes affect the texture of the osmotic dehydrated foods. Sucrose present in fruits and vegetables acts as an important factor influencing the texture of foods.

Color analysis of the ready-to-eat coconut based snack

Figures 3, 4, 5 and 6 reveals the color characteristics of ready-to-eat coconut based snack.

On analyzing the color parameters, the control samples possessed significantly lesser ($p \leq 0.05$) chroma values (T_1Control-4.64, T_2Control-4.94) than samples impregnated with functional filtrates with respect to the changes in the intensity of hue values. Irrespective of the drying method adopted, higher chroma values was observed in the impregnated samples D (T_1D-17.40, T_2D-17.14) and C (T_1C-13.9, T_2C-13.94) which could be due to the presence of colored pigments with grater intensity when compared with sample A (T_1A-10.50, T_2A-9.70) and sample B (T_1B-6.65, T_2B-5.87)

The a* values of the hot air oven dried samples C and D found to possess slightly higher values than freeze dried samples due to enzymatic degradation of pigments which was in agreement with the finding of Krokida *et al.,* (2000) [8] who reported that the a* chroma value of air dried samples increase significantly during air drying. The increase of the a-value denotes a more redcolor, which is indicative of the browning reaction.

A small increment in b* values (yellowness) was observed in all functionally infused coconut samples of both drying methods than control samples corresponding to the increase in a* values which was consistent with the result of Krokida et *al.,* (2000) [8] who indicated that there was an increment in the b* values (yellowness) which was observed in untreated

samples of banana whereas slower increase in b* value was observed in osmotic treated samples. However the chroma and total color difference of the freeze dried infused samples found to possess slightly lesser values than hot air dried samples indicating meager degradation of pigments. The increment in the total color difference was measured with reference to the 3 co-ordinates L*, a* and b* where lower lightness and higher a* and b* values were observed.

The hue angle value of sample D of both the drying methods was found lowest than standard 90° hue angle which represents the presence of orange-red color, followed by hot air dried sample C with hue angle of 83.34, freeze dried sample C of hue angle -85.39, followed by hue angles of sample T_1B and T_2B (-82.83 and -80.52), finally control snack and sample T_1A and T_2A possessing hue angle values nearer to 90º which specifies the yellowness and greenness of the samples. The increase in chroma and total color difference values represents the extent of change in color during osmotic dehydration and also reduction of pigments occurred during drying process which could be related to the concept of Larrauri *et al.*, (1998) [11].

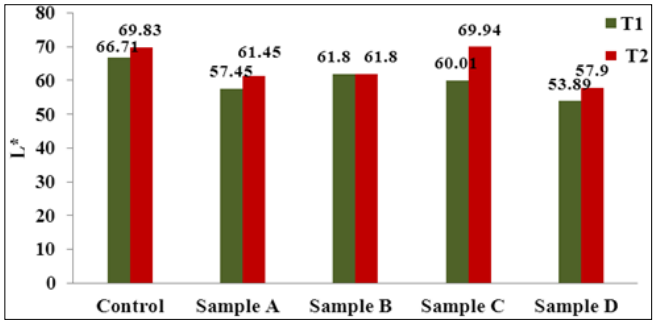

Fig 3: L*(Lightness) value of the ready-to-eat coconut based snack

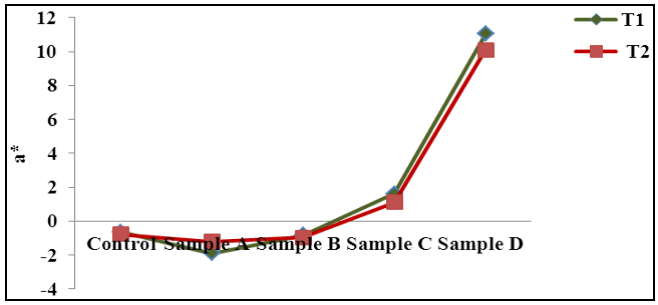

Fig 4: a*(redness-greenness) value of the ready-to-eat coconut based snack

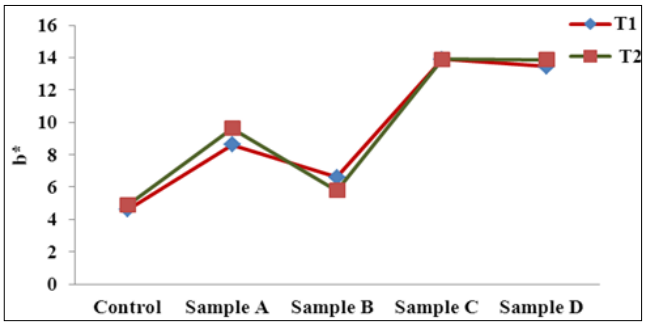

Fig 5: b*(yellowness-blueness) value of the ready-to-eat coconut based snack

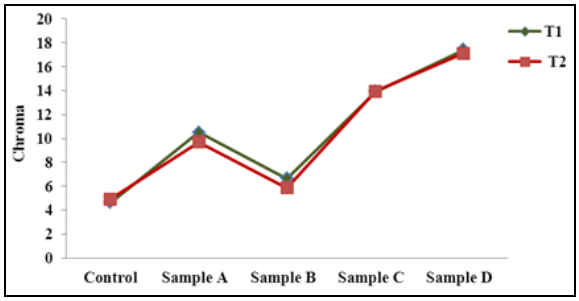

Fig 6: Chroma value of the ready-to-eat coconut based snack

Shelf-life and sensory characteristics of the ready-to-eat coconut based snack.

Microbiological analysis of the ready-to-eat coconut based snack during storage

The Table 2 explains the microbiological analysis of the ready-to-eat coconut based snack.

The total microbial counts (cfu/grams) of osmotic treated T_1 as well as T_2 samples were shown with slight progress in microbial growth but was found safe during 3 months of storage periods with good sensory acceptability scores as suggested by panelists. As the ready to eat coconut based snack was impregnated with functional filtrate and sugar (52ºBx) which serves as a preservative and packed in aluminium foil laminated LDPE pouches of thickness 0.08mm with the application of nitrogen gas under MAP technology limited the permeability of air to curtail the growth of microorganism. Generally the osmotic dehydrated products packed under MAP had a better preservation of color with good microbial conditions and the organisms which are responsible for contamination are destroyed on blanching, the temperatures are found fatal to the growth of moulds and yeasts. In the present study, blanching was carried out at the beginning of osmotic dehydration process either with or without the functional infusions.

Table 2: Microbiological analysis (CFU/g) of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Storage period	T_1 samples cfu /gram	T_2 samples cfu /gram
A	0 month	$2x10^2$	$1.2x10^2$
B		$2.4x10^2$	$1.4x10^2$
C		$1.1x10^3$	$2.1x10^3$
D		$3.1x10^2$	$1.5x10^2$
Control		$3.5x10^3$	$2.4x10^3$
A	1st month	$1.2x10^5$	$2.1x10^5$
B		$2.1x10^4$	$1.2x10^4$
C		$1.6x10^5$	$1.3x10^5$
D		$3.2x10^5$	$2.6x10^5$
Control		$2.5x10^6$	$2.2x10^6$
A	2nd month	$1.4x10^6$	$2.2x10^6$
B		$1.2x10^5$	$1.4x10^5$
C		$3.1x10^6$	$2.3x10^6$
D		$2.3x10^6$	$3.1x10^6$
Control		$2.5x10^7$	$1.6x10^7$
A	3rd month	$1.4x10^7$	$1.2x10^7$
B		$1.2x10^7$	$1.6x10^7$
C		$1.6x10^7$	$1.3x10^7$
D		$1.2x10^7$	$1.2x10^7$
Control		$2.2x10^8$	$1.8x10^8$

Sensory analysis

The sensory score on coconut based snacks either with or without the infusion of functional extracts examined over a storage period of 90 days for every 15 days interval and the scores were analysed for significance at $p \leq 0.05$. In the present study osmo-treated hot air oven dried ready-to-eat coconut based snacks consisted of greater color, flavor, texture, taste and overall acceptability scores than freeze dried ready-to-eat coconut based snacks in all the infusions. However sensory scores on all aspects decreased with increase in storage period.

Color of the ready-to-eat coconut based snack during storage: Table 3 describes the color of the ready-to-eat coconut based snack during storage.

Table 3: Color of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Drying methods	Storage period (days)							p-value	Mean
		0	15	30	45	60	75	90		
Control	T_1	6.7±0.5^a	6.7±0.5^a	6.7±0.5^a	6.5±0.10^a	6.5±0.1^a	6.40±0.20^a	6.40±0.20^a	0.482 ^{NS}	6.557
	T_2	6.0±0.30^a	6.0±0.30^a	6.0±0.30^a	5.90±0.90^a	5.90±0.90^a	5.70±0.40^a	5.70±0.40^a	0.172 ^{NS}	5.88
A	T_1	7.7±0.02^a	7.7±0.02^a	7.7±0.02^a	7.5±0.1^a	7.5±0.05^a	7.4±0.30^a	7.4±0.30^a	0.202 ^{NS}	7.56
	T_2	7.43±0.03^a	7.43±0.03^a	7.43±0.03^a	7.41±0.40^a	7.41±0.40^a	7.38±1.0^a	7.38±1^a	0.006 ^{NS}	7.41
B	T_1	8.40±0.3^a	8.40±0.3^a	8.40±0.3^a	8.0±0.3^a	8.0±0.3^a	7.90±0.5^a	7.90±0.5^a	0.316 ^{NS}	8.1
	T_2	8.10±0.02^a	8.10±0.02^a	8.10±0.02^a	8.0±0.30^a	8.0±0.30^a	7.90±0.50^a	7.90±0.50^a	0.250 ^{NS}	8.01
C	T_1	7.80±0.60^a	7.80±0.60^a	7.80±0.60^a	7.70±0.02^a	7.70±0.02^a	7.70±0.02^a	7.70±0.02^a	0.055 ^{NS}	7.74
	T_2	7.70±0.02^a	7.70±0.02^a	7.70±0.02^a	7.40±0.30^a	7.40±0.3^a	7.30±1^a	7.30±1.1^a	0.296 ^{NS}	7.5
D	T_1	8.50±0.03^a	8.50±0.03^a	8.50±0.03^a	8.40±0.40^a	8.40±0.40^a	8.30±0.20^a	8.30±0.20^a	0.422 ^{NS}	8.41
	T_2	7.80±0.60^a	7.80±0.60^a	7.80±0.60^a	7.70±0.02^a	7.70±0.02^a	7.60±0.02^a	7.60±0.02^a	0.157 ^{NS}	7.71

All values are means of triplicate determinations± standard deviation (SD), T_1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

The scores on sensory attribute color of the coconut based snacks observed at the end of 90th day ranged from 5.7 to 8.3, whereas initially (0th day), the range was 6 to 8.5. The sensory scores on color was found to diminish over the storage period. The decreased color scores during storage period may be due to the residual action of polyphenolases or other chemical interactions on color attribute which was reported by Irigoyen *et al*., (2005) [5].

Flavor of the ready-to-eat coconut based snack during storage: Table 4 explains the flavor of the ready-to-eat coconut based snack during storage.

Table 4: Flavour of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Drying methods	Storage period (days)							p-value
		0	15	30	45	60	75	90	
Control	T_1	6.6±0.5^a	6.5±0.1^a	6.5±0.10^a	6.4±0.20^a	6.4±0.20^a	6.3±1.1^a	6.3±1.1^a	0.082 ^{NS}
	T_2	5.8±0.6^a	5.8±0.6^a	5.8±0.60^a	5.7±0.40^a	5.7±0.40^a	5.4±0.2^a	5.4±0.2^a	0.466 ^{NS}
A	T_1	7.8±0.05^a	7.0±0.05^{ab}	7.8±0.05^{ac}	7.7±0.030^d	7.73±0.03^{de}	7.6±0.01^f	7.62±0.1^{fg}	0.003*
	T_2	7.0±0.5^a	7.0±0.5^a	7.0±0.50^a	6.80±0.60^a	6.8±0.60^a	6.7±0.4^a	6.7±0.4^a	0.229 ^{NS}
B	T_1	8.9±0.9^a	8.9±0.9^a	8.9±0.9^a	8.91±0.01^a	8.91±0.01^a	8.8±0.2^a	8.8±0.17^a	0.027 ^{NS}
	T_2	8.2±0.1^a	8.2±0.1^{ab}	8.2±0.10^{ac}	8.1±0.02^{ad}	8.10±0.02^{ae}	7.7±0.02^f	7.7±0.02^{fg}	0.000*
C	T_1	7.9±0.5^a	7.9±0.5^a	7.90±0.50^a	7.8±0.60^a	7.8±0.60^a	7.7±0.02^a	7.7±0.02^a	0.116 ^{NS}
	T_2	7.4±0.3^a	7.4±0.3^a	7.4±0.30^a	7.38±1.0^a	7.38±1.0^a	7.36±0.04^a	7.36±0.04^a	0.003 ^{NS}
D	T_1	7.9±0.5^a	7.9±0.5^a	7.9±0.50^a	7.82±0.42^a	7.82±0.42^a	7.73±0.63^a	7.73±0.63^a	0.064 ^{NS}
	T_2	7.5±0.040^a	7.5±0.4^a	7.54±0.04^a	7.48±1.0^a	7.48±1.0^a	7.46±0.23^a	7.46±0.23^a	0.015 ^{NS}

All values are means of triplicate determinations± standard deviation (SD), T_1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

In food acceptability traits, flavor plays a major role. The flavor may be lost, oxidized or might be degraded during dehydration processes. Hot air drying results in thermal degradation or volatilization of flavor compound, while freeze drying results in production of products with retention of flavor compounds, but in contrary Lin *et al*., (1998) [10] stated that freeze drying are considered as tasteless products and generally results in larger losses of volatiles and in most cases this drying is not preferable due to its high cost.

The flavor scores observed among control and impregnated samples at 0th day ranged from 5.8 to 8.9, the scores found reduced at the end of 3 month of storage period (5.4 to 8.8). The coconut based snacks developed with the osmotic infusion of *Zingiber officinale* filtrate scored maximum 8.8 (T_1) might be due to the relative presence of volatiles.

According to Chavan and Amarowicz (2012) [2] who conducted study on osmotic dehydrated mango slices, noticed that the keeping quality could be kept safe with a relative humidity of 64.8 - 75.5 for the better retention of sensory traits like flavor, taste, color and texture.

Texture of the ready-to-eat coconut based snack during storage: Table 5 reveals the texture of the ready-to-eat coconut based snack during storage.

Table 5: Texture of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Drying methods	Storage period (days)							p-value
		0	15	30	45	60	75	90	
Control	T_1	6.57±0.50 ^{a}	6.50±0.10 ^{a}	6.50±0.10^{a}	6.40±0.20 ^{a}	6.40±0.20 ^{a}	6.3±0.1 ^{a}	6.30±1.10 ^{a}	0.082^{NS}
	T_2	5.8±0.60 ^{a}	5.80±0.60 ^{a}	5.80±0.60^{a}	5.70±0.40 ^{a}	5.70±0.40 ^{a}	5.4±0.2 ^{a}	5.40±0.2 ^{a}	0.466^{NS}
A	T_1	7.81±0.05 ^{a}	7.81±0.05^{ab}	7.81±0.05^{ac}	7.73±0.03^{d}	7.73±0.03^{de}	7.620±0.01^{f}	7.62±0.01^{fg}	0.003*
	T_2	7.00±0.50 ^{a}	7.00±0.50 ^{a}	7.0±0.50 ^{a}	6.80±0.60 ^{a}	6.80±0.60 ^{a}	6.70±0.40 ^{a}	6.7±0.4 ^{a}	0.229^{NS}
B	T_1	8.9±0.90 ^{a}	8.920±0.90^{a}	8.92±0.90 ^{a}	8.91±0.01 ^{a}	8.91±0.01 ^{a}	8.8±0.17 ^{a}	8.8±0.17 ^{a}	0.057^{NS}
	T_2	8.20±0.10 ^{a}	8.20±0.10^{ab}	8.20±0.10^{ac}	8.1±0.02 ^{ad}	8.1±0.02^{ae}	7.70±0.02 ^{f}	7.7±0.02^{fg}	0.004*
C	T_1	7.90±0.50 ^{a}	7.90±0.50 ^{a}	7.9±0.50 ^{a}	7.8±0.600 ^{a}	7.8±0.6 ^{a}	7.7±0.02 ^{a}	7.7±0.02 ^{a}	0.116^{NS}
	T_2	7.40±0.30 ^{a}	7.4±0.30 ^{a}	7.4±0.30 ^{a}	7.38±1.00 ^{a}	7.38±1.0 ^{a}	7.36±0.04 ^{a}	7.36±0.04 ^{a}	0.063^{NS}
D	T_1	7.90±0.50 ^{a}	7.9±0.50 ^{a}	7.9±0.50 ^{a}	7.82±0.42^{a}	7.82±0.42 ^{a}	7.73±0.63 ^{a}	7.73±0.63^{a}	0.064^{NS}
	T_2	7.54±0.040 ^{a}	7.54±0.0^{a}	7.54±0.04 ^{a}	7.48±1.00 ^{a}	7.48±1.00 ^{a}	7.46±0.23 ^{a}	7.46±0.23 ^{a}	0.055^{NS}

All values are means of triplicate determinations± standard deviation (SD), T_1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and vb Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

The sensory scores of texture decreased with increase in storage period. There was a slight decrement in crispiness which was observed with respect to meagre increase in moisture content through the storage period. The texture scores of the coconut based snacks among all the treatments varied from 5.4 to 8.8. Among the control and impregnated coconut based snacks, the greatest texture scores (crispiness) was possessed by sample B of *Zingiber officinale* filtrate impregnation 8.8-T_1 followed by *Daucus carota* 7.7 of T_1, T_2-7.36 and *Beta vulgaris* infused coconut based snacks 7.73 of T_1, T_2-7.46, finally A sample 7.62- T_1 6.7- T_2 showed the descending order of texture scores.

Chavan and Amarowicz (2012) [2] reported that microbial spoilage and increment in moisture content could be prevented by using good quality airtight containers to preserve osmo-dehydrated foods. The ideal packaging material Aluminium foil, laminated polypropylene pouches are recommended for storing such food materials. Also he observed that osmo-dried papaya stored in high-density polyethylene pouches at ambient temperature for six months period was acceptable. In the present study the packaging material Aluminium foil, laminated LDPE pouches had been used and depending on its permeable nature and the moisture increment noted with change in crispiness of the product.

Taste of the ready-to-eat coconut based snack during storage

Table 6 give details on the taste of the ready-to-eat coconut based snack during storage.

The scores of the attribure taste among the samples observed over 3 months storage period showed a declining trend ($p \leq 0.05$). Generally highest score on taste was bserved in T_1 samples. The scores on taste of the coconut based snacks among treatments varied from 6.21 to 8.48. The osmotic infusion of *Zingiber officinale* filtrate in the coconut based snacks scored maximum 8.48 (T_1). A slight decrement in crispiness was observed throughout the storage period which might have affected the taste and the degradation total sugar content could have caused lesser sweetness in the snacks.

Table 6: Taste of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Drying methods	Storage period (days)							p-value
		0	15	30	45	60	75	90	
Control	T_1	6.7±0.500 ^{a}	6.7±0.500 ^{a}	6.7±0.500 ^{a}	6.65±0.320^{a}	6.59±0.44 ^{a}	6.53±0.020^{a}	6.5±0.100 ^{a}	0.144^{NS}
	T_2	6.54±0.32 ^{a}	6.54±0.32 ^{a}	6.5±0.100 ^{a}	6.47±0.060^{a}	6.38±0.26 ^{a}	6.27±0.130^{a}	6.21±0.210^{a}	1.067^{NS}
A	T_1	7.8±0.600 ^{a}	7.8±0.600 ^{a}	7.8±0.600 ^{a}	7.63±0.050^{a}	7.54±0.04 ^{a}	7.45±0.20 ^{a}	7.33±0.020^{a}	0.674^{NS}
	T_2	7.2±0.500 ^{a}	7.2±0.500 ^{a}	7.13±0.30 ^{a}	7.04±0.040^{a}	6.8±0.600 ^{a}	6.68±0.070^{a}	6.56±0.230^{a}	1.431^{NS}
B	T_1	8.9±0.200 ^{a}	8.9±0.200 ^{a}	8.9±0.200 ^{a}	8.72±0.100^{a}	8.66±0.260^{a}	8.53±0.030^{a}	8.48±1.00 ^{a}	0.567^{NS}
	T_2	8.6±0.200 ^{a}	8.6±0.20^{ab}	8.59±0.07^{abc}	8.5±0.1^{abcd}	8.3±0.14^{de}	8.17±0.10^{ef}	8.0±0.300^{ef}	0.003*
C	T_1	8.2±0.100 ^{a}	8.2±0.100 ^{a}	8.1±0.02 ^{a}	8.1±0.0200^{a}	7.9±0.500 ^{a}	7.8±0.600 ^{a}	7.8±0.600 ^{a}	0.666^{NS}
	T_2	8.3±0.100 ^{a}	8.3±0.10^{ab}	8.1±0.02^{abc}	8.1±0.2^{abcd}	7.9±0.50^{cde}	7.7±0.02^{ef}	7.7±0.02^{ef}	0.003*
D	T_1	8.6±0.0200^{a}	8.6±0.02^{ab}	8.6±0.02^{ab}	8.5±0.03^{d}	8.44±0.08^{d}	8.31±0.03^{f}	8.28±0.1^{f}	0.002*
	T_2	8.0±0.300 ^{a}	8.0±0.300^{ab}	8.0±0.300^{ab}	7.6±0.02 ^{d}	7.52±0.1^{de}	7.48±0.01^{def}	7.42±0.07^{def}	0.003*

All values are means of triplicate determinations± standard deviation (SD), T_1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

Overall acceptability of the ready-to-eat coconut based snack during storage

Table 7 represents the overall acceptability of the ready-to-eat coconut based snack during storage.

The sensory score on samples either with or without the infusion of filtrate of functional ingredients was examined over a storage period of 90 days at an interval of every 15 days. The scores were analyzed and found to possess significance at $p \leq 0.05$. In the present study, the sample subjected to hot air oven drying showed higher scores in terms of color, flavor, texture, taste and overall acceptability (8.66 to 8.3) than freeze dried samples (8.28 to 7.41). Among the

impregnated samples, the sample B subjected to hot air oven drying had greatest sensory scores before and at the end of 3 months storage period. Similar finding on decrement in overall quality scores on osmo-dehydrated products during storage was observed by Rani and Bhatia, (1986) [17].

Table 7: Overall acceptability of the ready-to-eat coconut based snack (T_1 & T_2) during storage

Samples	Drying method	Storage period (days)							*p-value*
		0	15	30	45	60	75	90	
Control	T_1	6.3±0.10 ^{a}	6.3±0.10 ^{a}	6.3±0.10 ^{a}	6.22±0.11 ^{a}	6.11±0.11 ^{a}	6.0±0.01 ^{a}	5.92±0.70 ^{a}	0.931 ^{NS}
	T_2	6.2±0.10 ^{a}	6.2±0.1^{ab}	6.1±0.04^{abc}	6.4±0.02^{bcd}	5.8±0.5^{cde}	5.68±0.04^{def}	5.56±0.16^{ef}	0.003*
A	T_1	7.8±0.60 ^{a}	7.8±0.60 ^{a}	7.8±0.60 ^{a}	7.65±0.06 ^{a}	7.57±0.04 ^{a}	7.45±0.20 ^{a}	7.33±0.02 ^{a}	0.663 ^{NS}
	T_2	7.04±0.04 ^{a}	7.0±0.04 ^{a}	6.6±0.40 ^{c}	6.52±0.15 ^{cd}	6.48±0.02^{cde}	6.41±0.14^{cdef}	6.37±0.11^{cde}	0.002*
B	T_1	8.66±0.11 ^{a}	8.66±0.11 ^{a}	8.66±0.11 ^{a}	8.51±0.07 ^{a}	8.4±0.40 ^{a}	8.36±0.09 ^{a}	8.3±0.07 ^{a}	2.388 ^{NS}
	T_2	8.28±0.09 ^{a}	8.3±0.1^{ab}	8.2±0.10^{abc}	8.1±0.05^{abcd}	8.0±0.15 ^{de}	7.93±0.09 ^{e}	7.41±0.06 ^{f}	0.003*
C	T_1	8.1±0.02 ^{a}	8.1±0.2^{ab}	8.1±0.02^{ab}	7.88±0.14 ^{d}	7.67±0.11 ^{e}	7.56±0.07^{f}	7.47±0.11^{f}	0.002*
	T_2	7.63±0.05 ^{a}	7.6±0.5^{ab}	7.51±0.1^{abc}	7.4±0.30 ^{cd}	7.36±0.04^{cde}	7.26±0.04^{def}	7.15±0.04^{ef}	0.003*
D	T_1	8.2±0.10 ^{a}	8.2±0.10^{b}	8.2±0.10^{abc}	8.1±0.05^{abcd}	8.01±0.15 ^{de}	7.93±0.09 ^{e}	7.41±0.06 ^{g}	0.004*
	T_2	7.7±0.02 ^{a}	7.7±0.2^{ab}	7.5±0.06^{ab}	7.31±0.04 ^{d}	7.13±0.08 ^{d}	6.81±0.04 ^{f}	6.66±0.26 ^{f}	0.004*

All values are means of triplicate determinations± standard deviation (SD), T1- Hot Air Oven Drying, T_2- Freeze Drying Sample A-*Mentha piperita*, Sample B-*Zingiber officinale*, Sample *C-Daucus carota* and Sample *D-Beta vulgaris* filtrate impregnated coconut based snack, Rows followed by different alphabets are *Significantly different ($p \leq 0.05$), NS- Not Significant by LSD.

Conclusion

Impregnation of functional filtrates as osmotic medium is a potential technique for incorporation of solutes, proteins, minerals, vitamins, organic acids, sugars, bioactive substances, not only contributes physic-chemical changes favourably but provides way to enhance the shelf life and sensory properties of the snack during storage period. Though slight degradation effects observed in hot air oven dried samples than freeze dried ones, organoleptically hot air dried ones would be accepted by all age group of people due to its light caramelized flavor and crispy nature and pleasant color.

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